

INTEROPERABILITY

DZERO: A Different Kind of Networking

Batavia, Ill.—When you have 75 gigabytes per second of data whizzing by you for months on end, you need something more than your average Novell Inc. network.

At the Fermi National Accelerator Laboratory, streams of protons and anti-protons are sent into each other at an energy of 1.8 trillion electron volts—enough, the physicists hope, to produce a few instances of the never-before-observed top quark, a kind of subatomic particle. The more energy an accelerator has, the stronger the collisions it can produce, letting high-energy physicists detect rare and rarer subatomic particles.

To detect the top quark and other such particles, a \$50 million detector is inserted into section DZERO of the main ring of the Fermilab accelerator, a scientific instrument 4 miles in circumference. The DZERO detector has several different data acquisition subsystems which produce immense amounts of data to be filtered, looking for those few events that are of interest.

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The accelerator produces a collision every 3.5 microseconds. That's 300,000 events per second, each event being described in 100,000 data readouts coming out of the detector. With an average event size of 250,000 bytes, that works out to a data rate of 75 gigabytes per second.

Here's the rub. Top quarks are really rare, and there might be only one observed per day of operation. That means that you have to be able to wade through 6.48 petabytes (6.48 million gigabytes) to find one interesting 250-kilobyte event.

The first step in acquiring this much data is to throw most of it away. The first-level filtering is based on a trigger set by a mask of a few dozen of the data readouts. Events that fit the mask are dumped into custom boards put into 79 VME-bus crates. The boards are double-buffered, letting two back-to-back events be captured. This filtering gets the data down to a rate of 200 to 400 events per second.

A 320-megabyte-per-second data bus funnels events into a farm of 50 powerful Digital Equipment Corp. MicroVAXs. A scheduling system directs one of the idle MicroVAXs in the farm to grab each event—200 to 400 of them per second—and perform a more in-depth analysis.

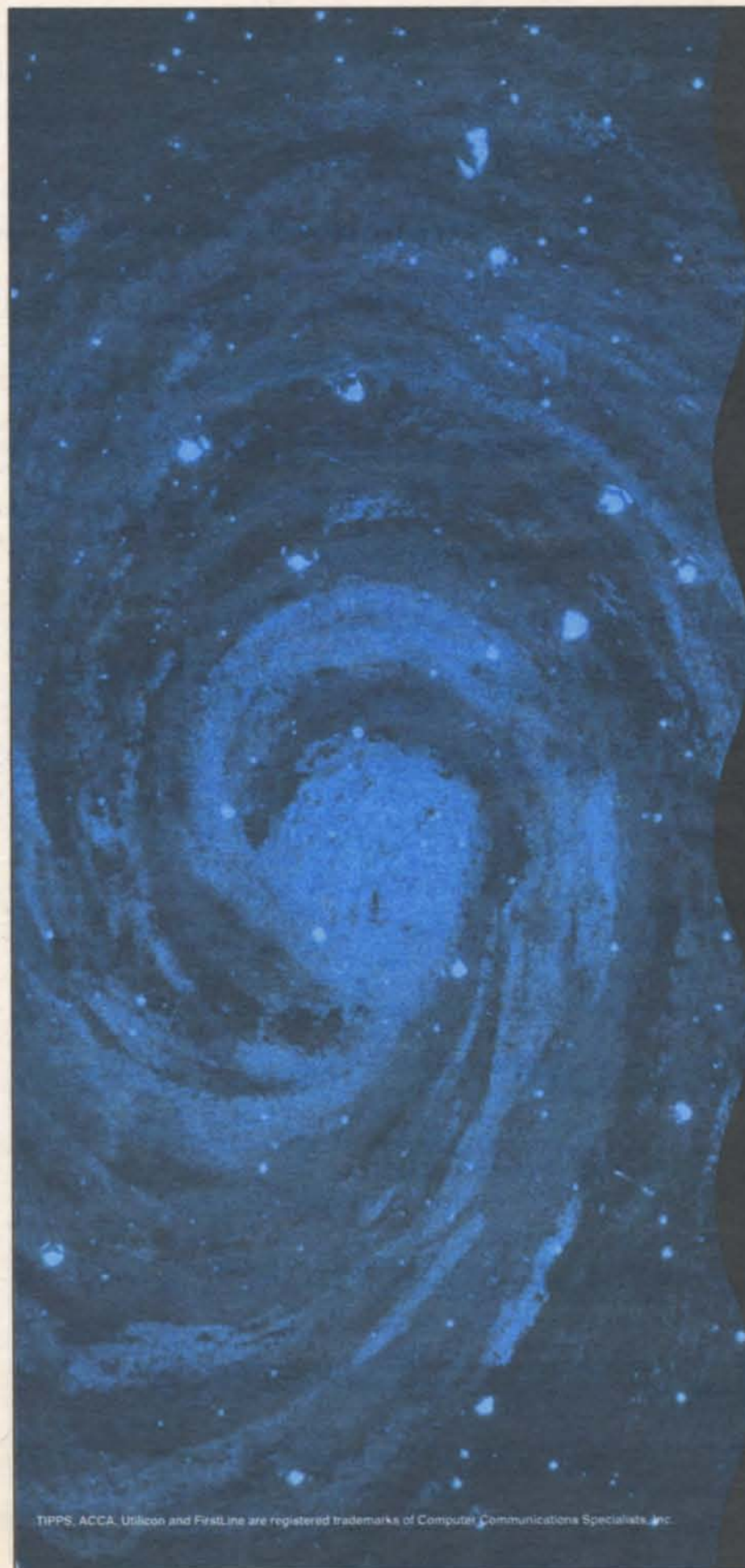
The MicroVAX runs a series of programs on the data to determine if the event

is really interesting. Events leaving the MicroVAX farm get filtered down to the rate of just 1 to 2 per second, still a substantial amount of data when you are running 24 hours a day, six to nine months at a time.

All the data that has survived the initial

filtering gets spooled off to tape for further analysis. A few events are flagged during the accelerator run as particularly promising and are analyzed immediately. The rest must wait for physicists to spend up to 30 minutes analyzing each event.

Along with physicists, space scientists are also preparing to capture and analyze petabytes and exabytes of data. The lessons learned from such high-volume applications will filter down to those of us dealing with gigabytes and terabytes. ■



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CARL MALAMUD is writing *Exploring the Internet: A Technical Travelogue*, a book that will be featured as *The Interop Book* at Interop '92 Fall. The opinions expressed are his own.